RADIATION FLUXES CALCULATION IN THE 8-12 μm REGION DUE TO WATER VAPOR TAKING THE LINE WINGS INTO ACCOUNT

Klimeshina T.E., Kozodoev A.V., Rodimova O.B.

klimeshina@sibmail.com, kav@iao.ru, rod@iao.ru

Institute of Atmospheric Optics SB RAS, Tomsk

The line form in the far-wing according to asymptotic line wing theory

$$\kappa^{W}_{a_j}(\omega) = D_{a_j} \frac{1}{\left|\omega-\omega_j\right|^{1+3/a_j}} \frac{1}{r_{a_j}} \int_0^{r_{a_j}} \frac{e^{-V(r,\Theta)/k\Theta}}{\sqrt{r_{a_j}^2 - r^2}} r dr = D_{a_j} \frac{1}{\left|\omega-\omega_j\right|^{1+3/a_j}} F\left(r_{a_j}\right)$$

absorption coefficients for the single line

$$V(r,\Theta_0) = \frac{4\varepsilon}{k\Theta_0}\left(\left(\frac{\sigma}{r}\right)^{12} - \left(\frac{\sigma}{r}\right)^{6}\right)$$

Quantum intermolecular interaction potential

$$r_{a_j} = \frac{C_{a_j}}{\left|\omega-\omega_j\right|^{1/a_j}}$$

Classical intermolecular interaction potential

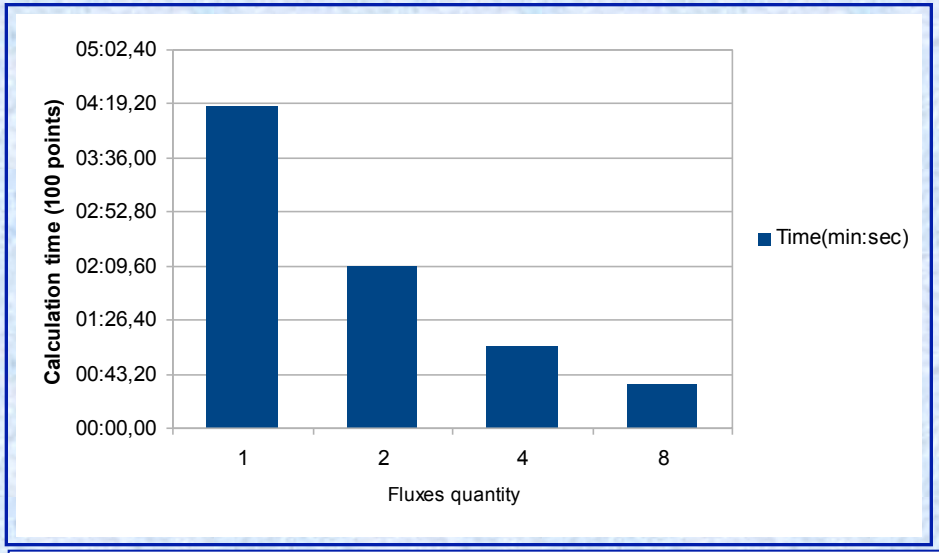
Radiation model

$$F_k^{\uparrow}(p) = 2\pi \int_0^{\infty} d\omega B(\omega, p = p_s) \int_0^{1} d\mu\, \mu e^{-\frac{1}{\mu}\int_{p=p_S}^{p} \kappa(p')dp'} + 2\pi \int_0^{\infty} d\omega \int_{p=p_s}^{p} dp' \kappa(p') B(\omega, p') \int_0^{1} d\mu e^{-\frac{1}{\mu}\int_{p'}^{p} \kappa(p'')dp''}$$

$$F_k^{\downarrow}(p) = -2\pi \int_0^{\infty} d\omega \int_{p}^{p=0} dp' \kappa(p') B(\omega, p') \int_0^{1} d\mu e^{-\frac{1}{\mu}\int_{p}^{p'} \kappa(p'')dp''}$$

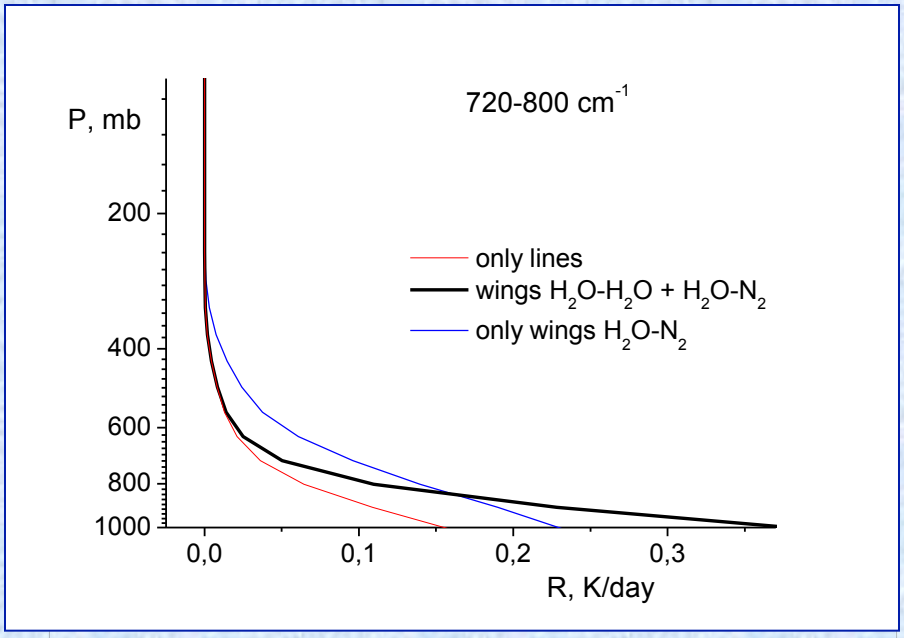
$$-\frac{\partial T(p)}{\partial t} = -\frac{1}{c_p g} \partial \left[F_{k+1}^{\uparrow}(p) - F_k^{\downarrow}(p)\right] / \partial p$$

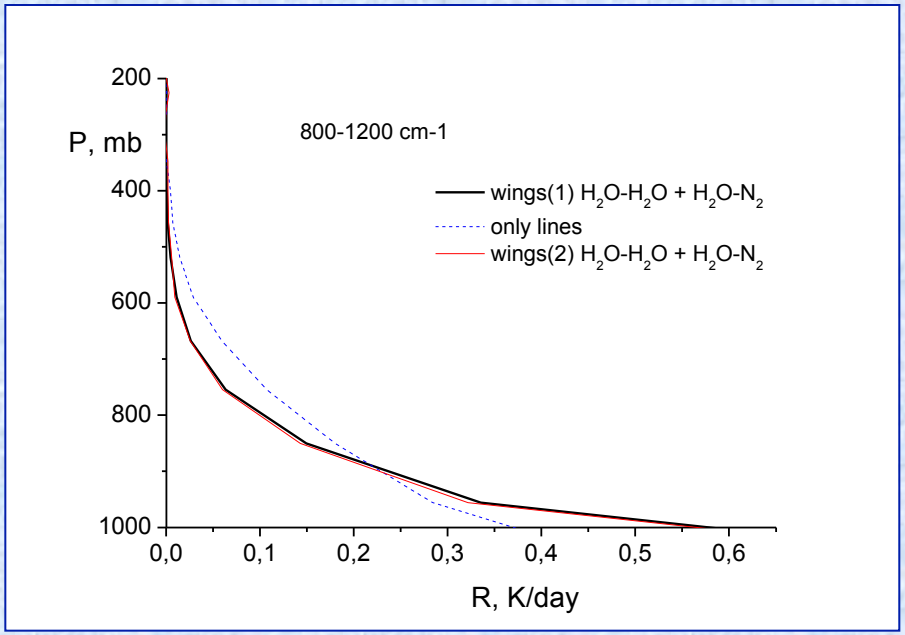
Calculation algorithm features



Calculating speed change when using of 1,2,4,8 central processing unit

Cooling rates caused by water vapor in terms of 33-layers midlatitudes summer atmosphere model





— line-by-line calculation with step 0.1 cm^{-1}, and contour bound 10 cm^{-1}

— line wing theory contour calculation for $H_2O - N_2$ mixture with 0.1 cm^{-1} step

— line wing theory contour calculation no metering self-broadening

- - - line-by-line calculation with step 0.1 cm-1, and contour bound 10 cm-1

— line wing theory contour calculation for $H_2O - N_2$ mixture with 0.1 cm^{-1} step

— line wing theory contour calculation for $H_2O - N_2$ mixture with 0.01 cm^{-1} step

Summary

In 800-1200 cm^{-1} spectral range radiation fluxes calculation, caused by water vapor, with line wing theory contour leads to cooling rates enhancing nearby ground surface in comparison with traditional for the radiation models line-by-line calculation in the 10 $см^{-1}$ range from the line center. Essential part of cooling rates changing results from self-broadening

It turned out that the code parallelization efficiency is high enough. Calculations time declines almost linear subject to central processing units quantity